THE INFORMATION REVOLUTION AND THE ENVIRONMENT OF FUTURE CONFLICT

A MONOGRAPH
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Abstract

The Information Revolution and the Environment of Future Conflict by Major George B. Hull, USA, 81 pages.

The world stands at the threshold of a new age; an age pregnant with great promise as well as new conflicts. A revolution is sweeping over the world that is as significant as any that has gone before in human history. A revolution in technology that manipulates and communicates information is thrusting fundamental change upon the world — an information revolution. An *information revolution* is a fundamental and complete change in the way knowledge or intelligence is communicated and received. Thus, the information revolution is about much more than powerful technology, no matter how significant. The heart of the revolution is the ability to communicate and receive information in ways never before possible.

Four hundred years ago at the dawn of the Industrial Age, commercialization and industrialization began to tear apart the world as it had existed for thousands of years. Over several hundred years of change it became today's world. The consolidation of what became known as the Industrial Revolution, changed the way men worked and earned wealth, the way men governed themselves, the relations between nation-states, and the way men fought wars. The information revolution portends similar fundamental changes in society.

The information revolution is changing the world in a number of important ways. The power of nearly instantaneous communication of vast amounts of information — a world with information at your fingertips — is shrinking the globe in time and diffusing power to individuals and groups. This in turn, is eroding the power of hierarchies both within business and government and its institutions. The information age has given rise to a society of organizations that have special interests and greater influence than in the industrial age past. Activities of business and government occur under the scrutiny of these various organizations. Neither government nor business controls their own destiny. Business and non-governmental organizations are increasingly global in outlook. The interconnectedness of the world in the information age gives less meaning to national identity. Collectively, these changes are changing the character of global competition, diplomacy, politics, power and conflict.

The information revolution is changing the environment of conflict. The revolutionary changes in computers, networking, telecommunications and the mass media are fundamentally changing the world. Distance, geography and national borders mean far less than they did twenty-five years ago. The combination of the mass media and the Internet are spreading cultural changes throughout the world, and in some areas seeding unrest and dissatisfaction. International politics, once the purview of diplomats and heads of state is now often affected by special interest groups, assembled as virtual organizations held together by computer networks, Internet newsgroups and e-mail. Today, diplomacy is often played out on CNN, as nation-states communicate messages to one another. The widespread availability of nearly instantaneous information and media images is making it more difficult to govern and is eroding national sovereignty. Computer networks are moving information past normal hierarchical channels and weakening organizational hierarchies. Globalization, transnational markets, transnational organizations and the rise of power of small groups and individuals define this new era. The information revolution is shrinking the globe in terms of time and is turning it into a true global village.

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Table Of Contents

Introduction

We are limited, not by our technology, but by the
way we think. We still think the way we thought
two hundred years ago, as if nothing had happened.
— Carver Mead[1]

The world stands at the threshold of a new age; an age pregnant with great promise as well as new conflicts. A revolution is sweeping over the world that is as significant as any that has gone before in human history. A revolution in technology that manipulates and communicates information is thrusting fundamental change upon the world — an information revolution. But just what is an information revolution? Webster's Dictionary defines *information* as "the communication or reception of knowledge or intelligence."[2] It defines *revolution* as "a sudden, radical or complete change" and as "activity or movement designed to effect fundamental changes in the socioeconomic situation."[3] Thus, an *information revolution* is a fundamental and complete change in the way knowledge or intelligence is communicated and received.

The definition derived for the information revolution implies the revolution is about much more than powerful technology, no matter how significant. For the technology only makes possible the communication, sharing, storage, retrieval, processing and manipulation of information. The heart of the revolution is the ability to communicate and receive information in ways never before possible. It is the rapid, widespread access to information brought on by the power of information technology that is causing the fundamental changes in human society. The information revolution has thrust the world to the threshold of the Information Age.

Four hundred years ago at the dawn of the Industrial Age, commercialization and industrialization began to tear apart the world as it had existed for thousands of years. Over several hundred years of change it became today's world. The consolidation of what became known as the Industrial Revolution, changed the way men worked and earned wealth, the way men governed themselves, the relations between nation-states, and the way men fought wars. The information revolution portends similar fundamental changes in society. Access to abundant information and the ability to share it widely and easily is conveying new power to individuals and groups. This power in the hands of individuals and groups may come to rival that of the nation-state. These changes and their interactions may produce an environment in which the societal interactions that lead to conflict could be far different than they have been in the Industrial Age.

The first glimmerings of the information revolution peaked over the horizon in the nineteenth century with the introduction of the telegraph. In the years that followed, the development of the telephone, radio and television, and the early computers though significant, only set the stage for what was to come. In 1971, the information revolution exploded with a supernova burst of creative energy whose effects are still multiplying today. In that year, three engineers at a tiny upstart company called Intel, created the Intel 4004, the world's first commercial microprocessor — a computer on a chip.[4]

The microprocessor and the information and telecommunications technologies it spawned, launched an information revolution that is fundamentally changing the distribution of political, economic and military power. It is a revolution that represents radical change in how information is collected, stored, processed, communicated and used. It is a revolution that is changing how corporations organize themselves to conduct

business, how governments govern, and how individuals interact with others in an extended society no longer limited to where they live. The world is a far different place, than it was twenty-five years ago, and the pace of technologically driven change is accelerating.

The information revolution is driving change in every area of society. Businesses and governments are reengineering themselves around the use of rapidly available information. Financial markets are interconnected globally. Events in one market can affect other markets almost instantaneously. Today, global markets are almost seamless for capital and commodities. Global news networks such as CNN, broadcast news worldwide almost as it happens. Mass entertainment available via satellite broadcasts to much of the world, is creating demands for change in less advanced societies. People, who share common interests, can assemble as virtual organizations in cyberspace, regardless of where they actually live. The World Wide Web, e-mail and the Internet are fundamentally changing how people seek and share information.

The Intel microprocessor that launched the information revolution had about 2300 transistors encoded in a 12 mm^2 silicon package. It provided roughly the same computing power as the world's first computer, the ENIAC, had with 18,000 vacuum tubes. Intel's sixth generation microprocessor contains 5.5 million transistors in a 196 mm^2 package. The number of transistors that can be placed on a single chip has been doubling roughly every eighteen months for twenty-five years.[5] This trend is expected to continue for some time. As the power of the microprocessor has increased, the cost of computing power has dropped.[6] The power of the microprocessor has spawned a wide range of associated information technologies. Microprocessors have made possible sophisticated computer

network systems, telecommunication systems, satellite systems and a host of other information handling systems.

Computer networks are the electronic catalysts of the information revolution. The physical connections of computers in networks have evolved into sophisticated information inter-networks. These networks penetrate every area of modern life. They include public switched telephone networks, cellular networks, defense data networks, local area networks, wide area networks, financial networks, transportation control networks, commercial and government satellite networks and the most well-known network of all, the Internet.[7] IBM estimates that in the mid-1990's there will be one billion computers connected to networks around the world.[8] These networks have fundamentally changed the way information is stored, processed, communicated and used.

The information revolution has also led to vast change in the telecommunications industry. The telecommunications system provides the backbone of the world's information infrastructure. The telephone system was once the realm of miles of thick copper cables strung throughout the country in complex networks — no longer. Today, fiber optic cables can carry the same information once carried in a thick trunk cable in an optic fiber the thickness of a human hair. Cellular telephone networks are being installed in many regions of the world that were never wired for basic telephone service. Many areas of the world, such as China, will go from a minimal telecommunication system, to a state of the art cellular system virtually overnight. Within a decade, Motorola plans to launch sixty-six satellites, which will provide cell-phone connectivity anywhere on the planet.

The satellite has brought information to the entire planet. Satellites not only support data transmission and telecommunication systems, but perhaps more importantly, provide the backbone for instantaneous transmission of mass media images throughout the world. The mass media can gather information around the globe, uplink it to a satellite with a suitcase-portable transmitter, and rebroadcast the report via satellite to the world within the hour. The widespread advent of television satellite receivers and Direct Broadcast Satellite systems make possible television reception anywhere in the world, without regard to ground based television stations or national borders. Future satellite technology will provide news organizations, and anyone else who wants to buy the information, with high-quality detailed images of regions of interest, previously only available to government intelligence agencies with vast resources.

The revolutionary changes in computers, networking, telecommunications and the mass media are fundamentally changing the world. The advent of the Industrial Age brought changes to the environment of conflict in the world. Industrialization changed the nature of economic relationships, political power and military power. The arrival of the Information Age augurs similar changes. This paper will explore the impact of the information revolution on the environment of future conflict. It will first consider how the information revolution affects society, then it will examine how the information revolution and its impact on society affect the environment of conflict in the future.

The Information Revolution and Society

Knowledge is the most democratic source of power.
— Alvin Toffler, 1990[9]

The foundations of the information revolution were laid in 1832 in the middle of the Atlantic Ocean. Samuel Finley Breeze Morse was returning home from three years of study as a portrait artist in Europe when he became engaged in conversation with fellow passengers on the experiments of French physicist André Marie Amperè in electricity and magnetism. In those conversations, the seeds of curiosity were sown in Morse's mind. By the time he docked in New York, Morse had sketched the broad outlines of the telegraph system — the transmitter, receiver and the code system to be used.[10]

Morse's telegraph was simple in concept, but revolutionary in effect. All it did was transmit information from one place to another. Its impact however, came from the speed with which it moved information. Before the telegraph, messages from one place to another might take hours, days, weeks or even months. The telegraph made the transmission of a message nearly instantaneous. It was the time compression that produced revolutionary change.[11]

In the hundred and sixty-five years since Morse conceived of the telegraph, advances in technology to communicate, share, store, and manipulate information have continued at a breathtaking rate. From its humble beginnings in the early nineteenth century, the information revolution has today expanded to touch every aspect of society. It is a revolution that is fundamentally altering the nature of human interactions throughout the developed world and to some extent the Third world. Its roots lie in four

converging technologies — computers, computer networks, telecommunications, and the mass media (See Appendix A — The Information Revolution for more information).

The widespread availability of these powerful converging technologies in cheap, reliable forms is fundamentally changing society. Since the 1950's the means for communicating, sharing, storing, retrieving, processing and manipulating information have exploded. In the last decade alone, almost any measure of the information revolution on nearly any dimension — *numbers* of telephone circuits, television sets, VCR's, or facsimile machines; *capacities* of transmission media, computer memory, storage devices, or displays; *speed* of computer CPU's, video display, mass storage device access, or data transmission — is described not by small percentages of growth but by near exponential growth.[12]

The information revolution is redefining the paradigm of economic success for societies across the world, and with this changing paradigm, the way members of society interact with one another and govern themselves. For four hundred years after the dawn of the industrial revolution, successful societies sought economic success and increased standards of living along the broad road to industrialization. Division of labor, factories on immense scales, hierarchical management and subordination of the individual to the group typified the industrial society. Mass-production, bureaucratization and centralized control were hallmarks of the industrial approach to business and government. It was a system that thrived by pushing information up to senior management and decisions down to workers. The industrial system's efficiencies of scale produced an economic boom that drastically raised standards of living and changed the industrial societies, as well as the world. Today, the developing third world still seeks this road to economic success.

However, a flood of change is reshaping the economic and political landscape. The information revolution that began so tentatively in the early 1800's with the invention of Samuel Morse's telegraph had by the 1950's matured into a significant force in the industrialized world. A fundamental shift in the demographics of the American workforce occurred in 1956. In that year for the first time, white-collar knowledge- workers outnumbered blue-collar industrial laborers in the American workforce.[13] By the 1990's, the traditional rules of the capitalistic industrial economy were undergoing tremendous change. The information revolution was producing what management observer and writer Peter F. Drucker termed an *Age of Discontinuity*.[14]

From Drucker's viewpoint writing in 1968, four points of discontinuity between the old industrialized society and the new developing information society brought about this *Age of Discontinuity*. First, the rapid emergence of new information technologies and new industries based on them. Second, the emergence of a world economy which changes the relationships between classes of society within nations and the relationship between the developed and developing world. Third, the emergence of new types of institutions that makes obsolete traditional theories of government and society. Finally, knowledge emerges as the new capital and central resource of an economy. In the 1983 preface to the current edition of his work, Drucker notes he would add one more major factor to the four he listed in his original work — the shift in population structures and population dynamics within the developed and developing world, as well as, between them.[15]

A more recent observer, economist Lester C. Thurow, makes similar observations in his 1996 book, *The Future of Capitalism*. Thurow, drawing an analogy from evolutionary biology asserts that the world is in a period of "punctuated equilibrium." In

biology, punctuated equilibrium occurs when the environment suddenly changes and the dominant species dies out and is replaced by some new species. When this happens, biologists say that evolution takes a quantum leap. Systems, whether biological or economic, enter periods of punctuated equilibrium with evolving but established structures and relationships. They emerge with radically different structures and return to stable, slow evolution. For Thurow, the industrial revolution represents one economic example of punctuated equilibrium.[16]

Thurow argues that today, five events are causing the world to experience another period of punctuated equilibrium. The first event is the end of communism, which led one-third of the world's population to seek the road to capitalism and economic success. The second event is the technological shift from industrial societies based on the possession of natural resources to brainpower industries that can be located anywhere. The third event is the changing population demographics caused by shifts of the world's poor seeking a better life. The fourth event is a global economy brought about by shifts in technology, transportation and communication that allow anything to be made anywhere in the world and sold somewhere else. Thurow's final event, is the arrival of an era where there is no dominant economic, political, or military power.[17]

Though nearly thirty years separate Drucker's and Thurow's works, they are very similar in outlook. They, and many other current observers, see the changes occurring in worldwide society as a result of the information revolution. Compared with the industrial revolution, the economic barriers to entry into the Information Age are relatively low. However unlike the industrial revolution, the educational barriers are quite high. Many areas of the developing world such as Singapore, Taiwan and enclaves within India and

Pakistan, are already strong participants in the information revolution and others areas will join in the future. Like the industrial revolution that preceded it, the information revolution is transforming societies, economies and international relations. It is creating change and destroying the accepted notions of the old industrial order. Out of the change, disorder and serious economic dislocation a new type of society is arising — an information society.

The Global Village and the Information Society

In 1968, Marshall McLuhan coined the term 'global village' as he examined the growing interconnectedness of the world.[18] The metaphor of the global village is an apt description of the changes the information revolution is bringing to the world. A world in which a worldwide news audience can watch real-time coverage of Patriot missile interceptions of Iraqi SCUD missiles in the night skies over Tel Aviv, Israel is a world that is perceptibly smaller than the one of just a few decades ago. Integrated global networks are carrying video, data and voice transmissions across national boundaries, shrinking the globe into one giant local network overcoming time and distance. These networks are already firmly established and grow in sophistication, capacity and pervasiveness every year. Groups of people with common interests are forming virtual organizations linked by computer networks and information technologies. Today, it is very possible to know things, do things, and interact with others around the world as if all were in the same local village.

Computers and their networks have become communication systems of the first order. In an example of academic cooperation in 1990, researchers at the Massachusetts

Institute of Technology, the University of Chicago, in Israel and at other sites collaborated on a difficult mathematical problem. An MIT researcher posted an intriguing mathematical hypothesis in a USENET discussion group on the Internet. Seventeen days later another researcher posted an insight into the problem. Thirteen days after this, a researcher in Israel posted a key result and finally twenty-two days later, researchers at the University of Chicago put the finishing touches on the results.[19] This example is repeated daily in academia, business and government.

Information technologies also allow groups to form and coordinate effectively, even when members are isolated from one another. A quick survey of on-line services, such as America On-Line or CompuServe, reveals many discussion groups on topics of social, political and recreational interests. In the recent 1994 and 1996 U.S. elections, some candidates used discussion groups on on-line services to promote their political viewpoints and answer questions from voters. Others set up World Wide Web pages to provide information on their campaign. Voters used information on the Internet to compare candidates — finding out where candidates stood on issues and reviewing their voting records.[20] Special interest groups use information technologies to do the same thing. A World Wide Web search will produce thousands of links to web pages on a range of controversial political issues such as abortion, capital punishment, and environmental activism. Information technologies are creating a new era of politics.

Information technologies make it easy for people to coordinate across the boundaries of business firms and across wide regions. This new flexibility is beginning to reverse the Industrial Age trend towards large, integrated firms. Under the Industrial Age model, a firm derived economies of scale by producing all the sub-components of their

products, assembling them into final form, warehousing the products and finally distributing them. Information Age technologies have allowed the return of firms that are functionally specialized. These firms work together in loose networks with other specialized firms to produce and distribute products that would previously been produced, warehoused and distributed by a large, integrated firms. These networks of firms are more flexible, more focused, and more sensitive to market conditions than the larger, integrated firms of the Industrial Age. They typically succeed because they are able to use information to add value to whatever process they specialize in.[21]

For example, the General Motors Saturn Plant in Spring Hill, Tennessee has formed a network of alliances with its parts suppliers that is highly unusual by Industrial Age standards. Saturn gives its suppliers direct electronic access to its plant production schedule. The suppliers do not wait for a purchase order from Saturn; they simply examine the production schedule and deliver the parts Saturn will need to manufacture the cars the plant is scheduled to produce. It is the supplier's responsibility to show up at the right time and place with the right quantity of parts to meet Saturn's needs. After the parts are shipped, the supplier sends Saturn an e-mail message confirming shipment. Upon receipt, the parts are scanned electronically by a receiving clerk and routed to the correct part of the plant. This process automatically generates an electronically transmitted payment to the supplier's bank account.[22]

Today, businesses also use information technology to become more responsive to their customers. Information technology allows tasks to be programmed and adjusted continuously. In the clothing business, Levi Strauss can take a customers measurements in a department store, enter them on a computer terminal and transmit them directly to the

Levi factory in California. Using those measurements, Levi cuts out a pair of jeans that will exactly fit the customer, sews them together, and then express mails them to the customer. Two or three days after entering the store the customer is wearing a pair of custom tailored jeans.[23] This type of manufacturing is spreading into many industries. Products from computers to industrial seals may be custom specified, produced and shipped within days. Mass-production is giving way to custom manufacturing.

The information revolution's implications for society are profound. It is affecting the way society communicates, the way it advances knowledge, and the way it does business. This revolution is changing the relationship between members of society and their institutions. Revolutions often transfer power from one group in society to another. But most revolutions merely transfer power from the established elite to a group that becomes the new elite. The information revolution is transferring power not to a small group of elites but to a broad range of groups and individuals.

Prior to the information revolution, the ability of individuals to communicate freely was limited by geographic proximity and especially by national borders. Today, information flows freely around the world and crosses borders with increasing ease. Even governments such as Iran or China which attempt to restrict the flow of information from outside their countries, are being penetrated by satellite transmissions, audio and video cassette tapes, facsimile machines and computer networks. Governments are finding it increasingly difficult to deny their people Information Age technologies and at the same time participate in world economic markets. As worldwide information technologies link people across the world the effects will be seen in four principal ways:

1. The rise and maturation of an economy based on the productive use of information rather than natural resources.
2. The development and spread of global markets, transnational businesses and private organizations.
3. The weakening of traditional hierarchical organizations and the emergence of the networked organization.
4. The erosion of the prerogatives and sovereignty of the traditional nation-state.

An Information Economy

Building on the foundations of the industrial economy, information technologies are producing an entirely new economy — an information economy — as different from the industrial economy, as the industrial economy was from the agricultural economy. Just as the industrial revolution did not eliminate agriculture, the information revolution will not eliminate industrial manufacturing. However, as the industrial revolution marginalized agriculture as a source of societal wealth, so also will the information revolution eclipse industrial manufacturing. In the future, the dominant capital expense will be for information, either for the skills of workers or for the data necessary to conduct business. As the world's economy becomes dominated by information, the economic product will consist of information. The wealth of the world will become dependent on the acquisition and productive use of knowledge and information.[24]

The industrial economy was based on access to natural resources and investment capital. The availability of investment capital, natural resources and labor determined the

economic destiny of the industrial state. New York became America's biggest city because it had the best natural harbor on the East Coast and the investment capital to build the Erie Canal to the Midwest. Pittsburgh became the iron capital of the country, because of the location of nearby coal deposits, iron ore deposits and the presence of rivers and lakes that could be used for transportation. Thus the success of a region or a country was often tied to natural resources and the investment capital to exploit them. Consider that in 1900, ten of the twelve largest companies in America were natural resource companies.[25] Countries earned their wealth by using their natural resources to produce marketable goods.

A list of the fastest growing industries in 1990 demonstrates the changes brought about by the information revolution. The fastest growing industries include "microelectronics, biotechnology, material sciences, telecommunications, civilian aircraft manufacturing, machine tools and robots, and computers (both hardware and software)."[26] All of these industries are knowledge industries based on the exploitation of information and the development of new knowledge. They could be located anywhere on the planet that has the necessary human capital — the educated knowledge-workers. Natural resource endowments no longer determine the economic fate of a country.

The availability of investment capital is no longer the constraining factor it once was. The world capital market is now essentially a commodity market with three large trading centers — New York, London and Tokyo. Today, a Pacific entrepreneur with a sound business plan can build a capital-intensive plant in Bangkok, Thailand as easily as in Europe or the United States. The differentiation between capital rich and capital poor

countries is passing away. In the information economy, knowledge and skills are the source of competitive advantage.[27]

In the information economy, inventing new products without becoming the low cost producer gives one little economic advantage. Low cost production is only partly due to low labor wages. More important is mastering process technologies to assemble products at the lowest cost. This mastery is a fundamental skill in the information economy. Economic mastery within an industry will come to those who can apply information to develop and bring into production new products so fast that there is little chance for competitors to enter the market.[28] Intel Corporation produces a new generation of microprocessors about every thirty-six months. But within the 36 months that a generation of microprocessors is on the market there is an average of four to five incremental upgrades. Intel's competitors, AMD and Cyrix, have never successfully kept up with Intel in introducing competitive microprocessors. As AMD or Cyrix introduce a competitive product, Intel is moving on to a newer and more capable product.

If investment capital and natural resources are no longer the constraining factor for economic success, a new factor has taken their place — knowledge. Knowledge has become the only source of long run, sustainable, competitive advantage. However, knowledge can only be employed through individuals. A successful information economy is one that produces and retains skilled and knowledgeable individuals. Information based industries are not tied to any one location in the world by natural resources. They can and will locate wherever they find the necessary skilled and educated individuals and information infrastructure to support them. Likewise, intellectual capital will go where it is wanted and stay where it is well treated. Its movement across borders cannot be

stopped. Nations which impose high taxes, burdensome regulations or which attempt to repress information flow sill soon find that they do not have enough intellectual capital to compete in the Information Age's global marketplace.

The Global Economy and Transnational Enterprises

Information technologies applied to basic industrial production and transportation processes have created a global economy. As economist Milton Friedman observed, "It is today possible, to a greater extent than at any time in the world's history, for a company to locate anywhere, to use resources from anywhere to produce a product that can be sold anywhere."[29] Geography and local conditions need no longer condemn those with the intellectual skills to chronic underemployment. The world is increasingly bound together by an electronic delivery system including telecommunications, computer networks and global broadcasting through which information, news and money move with extraordinary ease and speed.

Speed is everything. Businesses, intent on minimizing production time and maximizing the flow of raw materials into finished goods, employ just-in-time systems for inventory, ordering, manufacturing, and management, all designed and implemented on a global scale. Old information is worthless. The world marketplace sees all and demands what it sees, no matter where it is produced. It is as easy to buy a pair of Levi jeans in London or Bangkok as in Los Angeles. A maker of industrial robots could place its manufacturing facility in Europe, its finance division in the United States and its marketing staff in Asia. Dispersed enterprises can take advantage of talent, tax codes, labor and resources that may vary from one part of the world to another. Transnational enterprises

may through careful location of operations, avoid tariffs, unfavorable tax laws and excessive regulation. In a global economy powered by information technologies, businesses locate facilities where it makes the best economic sense and where the human labor and intellectual capital is best suited for the work to be done.

Transnational businesses are taking advantage of these trends to move work to places once associated primarily with the third world. Big-Six accounting firms are performing computer-assisted audits for American clients using custom software written by Filipino programmers and shipped via satellite back to the United States. In other cases, raw financial data is shipped electronically to the Philippines, where locally educated accountants perform the audits and then electronically return the results to the U.S. The Philippines is not unique. Indians write millions of lines of code for American Express to use in data centers. Construction and engineering firms are using computer-assisted designs done in Taiwan to build structures around the world. All of this work is being done by skilled labor in their own countries, even though the products are often used half a world away.[30]

If the location of intellectual workers means little to where work is done, the identification of a modern corporation by some national identity means even less. The automobile industry, which is often perceived along classic national lines, illustrates the point. Automobile companies, like most large companies today have numerous alliances and partnerships, which call into question the ability to state whether their product is for example, American, Japanese, or even German. Chrysler, for instance, owns 24% of Mitsubishi Motors, which in turn owns part of the South Korean company Hyundai. Mitsubishi produces cars bearing the Chrysler nameplate and Chrysler builds Mitsubishi

cars in Illinois. Likewise, Ford owns 25% of Mazda, Mazda makes cars in America for Ford, and Ford makes trucks for Mazda. Each one of these companies owns a piece of Korea's Kia Motors. Ford and Nissan swap vehicles in Australia, while Ford and Volkswagen are a single company in Latin America that exports trucks to the United States. General Motors owns 41% of Isuzu, which is part of a joint venture with Subaru, which in turn is partly owned by Nissan.[31] Similar examples could be produced in almost any industry.

In the Information Age, modern corporations have discovered that information technologies make it possible for them to outsource many functions once done in-house. This trend started with functions such as payroll, warehousing and other support functions. But in time, corporations discovered that in many cases even manufacturing could be outsourced. The archetype of this type of company is Cyrix Corporation. Cyrix is a designer and producer of sophisticated computer CPU's and other integrated circuits. Yet Cyrix does not own a single manufacturing facility. It contracts its production work to other companies that own the billion-dollar facilities required to manufacturer the integrated circuits. Thus the virtual corporation is an entity with headquarters functions, but no manufacturing facilities.

This trend is firmly established in the advanced information states. Countries such as the United States already derive 70% of their Gross Domestic Product from services. Countries such as Holland have moved most of its manufacturing activities outside the country. In Switzerland, 98% of Nestle's manufacturing facilities are outside Switzerland. As a result of these trends in the organization of corporations, the world may become divided into "head" nations and "body" nations. Advanced information nations such as the

United States or Canada are examples of "head" nations while China is an example of a "body" nation that can economically produce marketable goods. [32]

The trend towards globalization and transnational organizations is firmly rooted in the effects of the information revolution. Information technologies are reducing the costs of communication and making national borders irrelevant. The importance of geography and distance in limiting relationships and restricting communication is declining. Professional, economic, educational, political, and social relationships will occur without regard to geography and distance. Transnational organizations know no boundaries. They are not identified by any one nationality.

The Weakening of Hierarchies

Hierarchy is a fundamental human institution and one that is under assault by the information revolution. Hierarchies have existed in one form or another as long as man has gathered into formal societies. However, prior to the industrial revolution, most organizations were simple, small and functioned in one location. The typical organization had few employees and could be effectively managed by a single individual. The simple, hierarchical organization evolved into its modern form as a result of the industrial revolution. During the industrial revolution, organizations increased vastly in size and complexity. These organizations were distributed among many locations separated by great distances. The number of employees in a typical organization increased from a few to thousands.

In the United States, the Erie Railroad pioneered an organizational structure whose imprint is evident in organizations today. Problems of control appeared early in the

railroad system. By the mid-nineteenth century, railroads had developed into the most complex, distributed organizations ever established. In the 1850's, the Erie Railroad's superintendent, Daniel McCallum, established a model organization to increase the railroad's safety and efficiency. He accomplished this with a hierarchical system of information gathering, processing, feedback, and error detection designed to centralize control at the superintendent's office. McCallum's system established formal hierarchy with functional divisions, lines of responsibility, and task specialization. But above all, his system was an information processing system for overcoming uncertainty and for facilitating communications and control.[33]

The information revolution is making the hierarchical form of organization less necessary. Daniel McCallum formed a complex, hierarchical system at the Erie Railroad in order to gather information, transmit it up to superiors who made centralized decisions, and then transmit those decisions back down to railroad workers for execution. Hierarchy can be viewed as an organizational response to limits in communication. Information revolution technologies are replacing hierarchies with viable, alternative pathways of communication. The hierarchical structure within organizations is being weakened by information technology as information is shared across organizational boundaries and between levels without traveling through the formal hierarchy.

The weakening of hierarchies in organizations has the effect of decentralizing control to those workers who are most knowledgeable of the problems to be solved. They use the power of Information Age technologies to locate the information they need, to work with other knowledgeable workers regardless of their location and to coordinate the efforts of geographically dispersed workgroups to solve problems. Companies who adopt

these organizational techniques are frequently more flexible and faster acting than those who adhere to the traditional hierarchical model of organization. In the Information Age, strict hierarchy is becoming a burden rather than an asset to productivity.

In traditional hierarchical organizations, many of the middle levels of the hierarchy fulfill information processing and filtering functions. Information Age technologies are making this role obsolete. The advent of global information networks and mass media has reduced the value added by multiple layers of information processing between the individual and the source of the information. Individuals can now sort through large amounts of information with computer based tools and make their own assessments. Hierarchies are no longer needed to serve as conduits and processors of information.[34] Information Age organizations will never be pure networks where every worker is a member of the same organizational level. They will be hybrid organizations with many of the characteristics of pure networks and enough hierarchical organization to coordinate their activities.

The Erosion of National Sovereignty

Sovereignty is the fundamental characteristic of the nation-state. To have sovereignty is to have freedom from external control and controlling influences. The information revolution is directly assaulting the concept of national sovereignty. The world is bound together in an electronic infrastructure that moves information at the speed of light. This infrastructure has radically altered the balance of information power, tipping it away from the state and towards the individual.[35]

The Information Age is not defined by the traditional roles of governments, sovereign nation-states, or international alliances, but increasingly by worldwide markets, transnational business and private organizations, and the nearly instantaneous transmission of information and ideas. Information technologies enable information and ideas to bypass hierarchical structures in cultures, business and government. The information revolution is noticeably eroding the traditional prerogatives and powers of governments and sovereign nations. The power conveyed by access to vast amounts of information is spreading rapidly to individuals throughout the world, especially to the most highly developed areas such as Europe, North America and Pacific Asia. Individuals and groups with abundant access to information and the ability to communicate readily and rapidly among themselves represent a challenge to the authority of governments.

Knowledge has always conferred power on those who have it and know how to use it. The convergence of computers, networking, telecommunications and the mass media has created a global arena of shared information that takes no notice of international boundaries. Special interest groups use the power of these converging technologies to economically promote their views and messages before the world. They often have a disproportionate impact for the resources consumed in publishing the information. For example, Amnesty International, a transnational special interest group, operates an action center from the home of a couple in a small town in Colorado which alerts the world to gross violation of human rights anywhere in the world.[36]

Other special interest groups use the power of the computer to assemble huge mailing lists targeted towards recipients likely to be swayed by the proposed message. A combination of computers and sophisticated phone systems has made possible a calling

technique known as predictive dialing patch-ins. Using this technique, special interest groups select motivated respondents from a database. They then contact these people rapidly by phone, persuade them to make an appeal to their elected representative, and then directly patch the phone call to the representative's office. For an issue in California, predictive dialing patch-ins turned a negative 4-1 vote before a county commission into a 5-0 victory.[37] This sort of technology can bring enormous perceived pressure to bear on political institutions.

The mass media is also a prime player in the distribution of information that impacts the abilities of sovereign nations to chart their own course. Before the advent of news networks such as CNN, there was such a thing as the daily news cycle. The story lineup for the evening news shows was set by early afternoon. If a government official wanted coverage of a speech or other announcement it was scheduled to occur around lunchtime. Newspaper deadlines were just after dinnertime. Every morning, the news was reviewed from the previous evening news shows and the morning papers and responses were prepared for later in the day.[38]

With the advent of CNN, C-SPAN, radio and TV talk shows there is no longer a daily news cycle. Opinions, accusations and issues arise endlessly throughout the day. The cycle of nonstop news has drawn governments into a cycle of nonstop responses. Such an environment constrains policy options and makes long-range planning difficult at best. The media affect governments in other ways as well.

Media reports supported with dramatic visual images can generate tremendous public pressures on politicians. The images of dead American servicemen being dragged through the streets of Mogadishu, Somalia forced the Clinton Administration to reverse its

Somalia policy despite the fact that U.S. force suffered only a small percentage of the casualties suffered by the Somalis. In another example, the display of images produced by the French earth resources satellite SPOT in 1986, forced the former Soviet Union to change its story concerning the Chernobyl disaster and admit that the event was much worse than it had previously acknowledged.[39]

The flow of information will not cease. The arrival of Direct Broadcast Satellite (DBS) systems is bringing high quality, easily accessible television coverage to much of the world. Television has become so efficient a news pathway that television sets tuned to CNN now sit in the military command centers of many nations. Television has developed into a force in world affairs and has become a weapon and method of diplomacy. The agendas of nations are increasingly being set not by parliamentary debate, or diplomatic policy, or even by executive decision, but by the media.

The impact of globalization and transnational organizations is also eroding national sovereignty. Nation-states will increasingly find their freedom of action curtailed by the availability of information to individuals and groups that reside both within and outside the borders of the state. The information revolution has already produced dramatic shifts in the ability of nation-states to regulate their currencies, to regulate and control markets and prices and to regulate and control businesses.

The issuance of currency and the establishment and management of central banks have always been closely associated with national sovereignty. The regulation of a nation's currency will serve to illustrate the problems nation-states face in trying to regulate business and markets. Today, the world financial market is comprised of more than two hundred thousand trading terminals all over the world linked together across

computer networks. No one controls this market, nor could they, for it operates on the collective evaluation of hundreds of thousands of traders evaluating financial information brought to them across the world's information networks. The market directly votes on a nation's financial policy making through its effects on the trading of the nation's currency. With over two trillion dollars a day changing hands in New York alone, there is not enough reserves in all the world's central banks combined to influence this market on more than a momentary basis.[40]

The inability of nation-states to regulate within their borders has led to a significant rise in the influence of supranational organizations that now influence national governments. Since many of the world's environmental, social and political problems have passed beyond the scope of individual nations, the world is increasingly looking to supranational organizations such as NATO, the United Nations, the World Trade Organization or the World Court to solve problems.

Just as supranational groups gain influence and power over nation-states, so also do subnational groups. The inability of most governments to control information dissemination means subnational political groups can use information technologies to promote their political viewpoint and attempt to bring pressure against their government. The Ayatollah Khomeini used cassette audiotapes to spread his message in Iran during his exile in France in the 1970's. In the late 1980's, videotapes circulated widely in Eastern Europe spreading information in support of the opponents of communism. In the United States, various militia groups have been early users of the World Wide Web. In Mexico, guerrilla insurgents operating south of Mexico City have used the World Wide Web to

promote their cause, appeal for funds and bring pressure to bear on the Mexican government.

Borders traditionally defined the boundaries of a nation's sovereignty. In the Information Age, borders are not boundaries. The information revolution is forcing a reexamination of what constitutes sovereignty. In the interconnected world being built by information technologies it is impossible to assert sovereignty over information or to keep citizens out of the global conversation made possible by the information revolution.

The information revolution is redefining the paradigm of economic success for societies across the world, and with this changing paradigm, the way members of society interact with one another and govern themselves. The power of the four converging technologies — computers, computer networks, telecommunications, and the mass media is shrinking the globe in time and diffusing power to individuals and groups. This in turn is eroding the power of hierarchies and reshaping businesses, governments and institutions. The Information Age has given rise special interest groups that have greater influence than in the Industrial Age past. Activities of business and government occur under the scrutiny of these various organizations. Neither government nor business controls their own destiny. Business and non-governmental organizations are increasingly transnational in character and global in outlook. The interconnectedness of the world in the Information Age gives less meaning to national identity. Collectively, these changes are changing the character of global competition, diplomacy, politics, national power and conflict.

The Information Revolution and the Environment of Future Conflict

> Knowledge in the form of an informational commodity indispensable to productive power is already, and will continue to be, a major—perhaps *the* major—stake in the worldwide competition for power. It is conceivable that the nation-states will one-day fight for control of information, just as they battled in the past for control over territory, and afterwards for control over access to and exploitation of raw materials and cheap labor.
>
> — Jean François Lyotard, 1979[41]

The transformation of the world by the information revolution is changing the environment of conflict. However the information revolution is only one of several strong currents cutting away the established political order as the flow of history seeks its course for the future. The fall of communism, the dissolution of the bipolar world, and the resurgence of nationalism and ethnic conflicts are intimately intertwined with the changes brought about by the information revolution. Like the flow of a river at flood stage, these modern trends in politics, society and economics form a seething flow of currents, eddies, backwaters and even the occasional whirlpool. Like the river, these trends form a chaotic system of interactions whose specifics are difficult to describe, but whose broad outlines and course emerge from its many parts for all to see.

The emerging world is one in which economic power may be more important than military power. Advanced information societies are becoming increasingly dependent upon knowledge to sustain prosperous economies. The emerging world is one in which there is an increasing dichotomy between the economic haves and have-nots. This increased disparity may lead to both economic and physical conflict as nations struggle to provide economic prosperity for their citizens. Traditional military conflict between states will undoubtedly still occur, but less advanced states will not be able to compete with

advanced information states on a symmetrical basis in physical combat. However, the information revolution has made the most advanced states vulnerable to attacks against their most vital national system — their information infrastructure.

The global information system that has evolved over the past twenty-five years has completely changed how information flows in the world and with it eliminated the ability of governments to control information flows to their populations. The economic changes brought about by the information revolution have created fundamental change that has led to economic interdependence among the advanced information states and their various international partners. It has also led to the emergence of powerful, non-state actors on the international scene. The combined effects of transnational and supranational actors along with widespread availability of information have drastically reduced the sovereignty of nation-states. The information revolution is changing the very nature of the modern nation-state system established in France during the seventeenth century.

The Rise of the Sovereign Nation-State

The modern approach to nation-state relations arose in France in the seventeenth century. Cardinal Richelieu, first minister of France from 1624 to 1642, was the father of the modern state system. Richelieu developed and wielded the concept of *raison d'ètat* as he oversaw the affairs of France. Under this concept, France pursued her actions purely as they related to her interests. The success of this kind of policy depended on the ability to assess power relationships. Though Richelieu's approach to international relations in the fifteenth century was novel and to his neighbors unsettling, he left Europe, and by extension the world, a legacy that only today is being uprooted.[42]

The balance of power politics that have predominated in nation-state relationships for the past four hundred years are Richelieu's legacy. The balance of power system did not develop to enable states to avoid crises or wars. This system was meant to limit the ability of states to dominate others as well as to limit the scope of conflict when it occurred. Its goal was not peace, but rather stability and moderation of state relations. The balance of power system assumed that the competition of states pursuing self-interest would prevent any one state from gaining an undue position of ascendancy over others.[43]

Out of the wreckage of communism, the dissolution of the bipolar world and the end of the cold war, a new political order is emerging. In the post-cold war world the United States is the only remaining superpower. Yet despite its military power, it does not dominate the world politically. Five or six major powers and a multiplicity of smaller states characterize the emerging international system.[44] In addition to the nation-states, other powers now stand on the world stage. The information revolution has enabled supranational organizations, transnational businesses and subnational political groups to influence the relations among nation-states. These various organizations and groups have drastically altered Richelieu's concept of a balance of power among states, with each advancing their own self interests.

The Future International Environment

The dissolution of the bipolar confrontation between the United States and the former Soviet Union has unleashed a dramatic restructuring in international relations. Over the past decade, the world saw the fall of communism. Many foresaw a wave of peace and democracy sweeping over the world. Finally, they hoped men would live in

peace. The reality has been quite different. Over the past decade, the world has been awash in conflict, ideological competition, and a resurgence of nationalism. Instead of peace, the world has become more tense and less stable. The trends for the future international environment are outlined below. [45]

The International Balance of Power. The nation-state will continue to exist both as a physical entity and a political power. However, its freedom of action — its sovereignty — will be much more limited than in the past. The likelihood of a single nation acting alone in defiance of the international community decreases, as the ability to distribute information on its actions nearly instantaneously to a worldwide audience increases. The lack of one or a few dominant political and military powers in the world leads to shifting and unstable power balances at the international, national and sub-national levels. Information Age technologies make it possible for subnational groups representing regional territories or even crime syndicates to challenge directly the power of the nation-state and in many cases limits its effectiveness on the world stage. Supranational and transnational organizations have become significant actors on the world stage whose authority and influence limit the sovereignty and actions of individual nation-states.

The Resurgence of Nationalism. Nationalism has replaced communist ideology as the leading source of conflict. Nationalism emanates from many sources — religious, tribal, ethnic, historical and territorial. Nationalistic movements can erode the power and legitimacy of established nation-states. Recent examples in the former Yugoslavia and in the separatist Russian Republic of Chechnya demonstrate the potential consequences. Information Age technologies make it possible for the organizers of nationalist movements to sow discontent among the citizens of a nation-state and recruit them to the nationalist

cause as true believers. In many cases, nationalistic causes span more than one nation-state. In some cases, a nation-state may use this cause to interfere in the affairs of another state. The plight of the Kurds illustrates this point. They are a nation without a state who reside in portions of Turkey, Iraq, Syria, Iran and the former Soviet Union. Each of these countries has complained about the threat the Kurds pose to their countries. There has also been conflict among many of these states as they pursued the Kurdish issue to their own national advantage.

Cultural Conflict. The information revolution has a decidedly Western flavor. The mass media and the Internet provide largely Western entertainment and information. Satellite broadcast of Western television, movies and music assault many cultures with an overwhelming dose of Western values and culture. In many cases, these values conflict with the social mores of the local society. The end result in some cases, is a backlash against Western values and Western entertainment. This cultural conflict is sometimes low-key, as in Chinese attempts to screen information entering the country or sometimes quite strong, as in Iran's total rejection of the West and its culture. Culture can become a focal point and a flashpoint leading to conflict.

Competition. The traditional balance-of-power theory was based on a small number of powerful, sovereign nation-states competing with one another. Smaller states would ally themselves with a larger, more powerful state. Because the number of major states were small, states could assess the potential power of a neighboring state or alliance in making decisions concerning international relations. The declining sovereignty and consequent reduction of power of today's nation-states calls this theory into question. In its place are rivalries between states and non-state groups for power — military, political

and especially economic. The economic power of information based economies is widening the gap between rich and poor states. The decline in the significance of land and natural resources has not allowed developing nations to follow the formerly broad road to industrialization and economic success. The road to success for less developed states in the future may lay in economic alliances, not military ones, with the advanced information economies of the world. However, the economic dislocation caused by the shifting means of economic success will likely lead to conflict as a means to attempt to redress economic problems.

Shifting Population Demographics. Population growth and increasing urbanization, especially in the less developed world places significant strains on the social and economic resources of the affected states. As peasants in the underdeveloped world move into urban areas in search of a better life they are often exposed for the first time to the global conversation made possible by the information revolution. Peasants who have known only toil for their entire life, and whose urban existence is in many cases little improvement, are now able to see Western television broadcasts such as *Dallas*. Television brings not only images of a luxurious lifestyle, but news and information on how people in other parts of the world live. In some cases, this leads citizens in the third world view their situation through the lens of perceived relative deprivation. This in turn can lead to demand for change that local governments in all likelihood cannot meet. The end result may be conflict as citizens seek to change their government in hopes of achieving a better life.

Ungovernability. The ability of a government to govern effectively is being eroded in much of the world. Transnational corporations are often richer and more powerful than

the nation-states in which they do business. Information technologies and globalization make it difficult for governments to implement and control economic policies. The inability to control their economy often leads to economic instability and insecurity for their population. The economic dislocation caused by the shift from the Industrial Age to the Information Age is causing insoluble structural unemployment. The economic success of the advanced information economies and their production partners (economic allies) is producing an economic rift between nations that are part of the information economy and those that are not. The impact of successful regions within countries, such as those in China, Pakistan, or India, that are otherwise still undeveloped sows seeds of discord and envy in the country's society. Information technologies make it possible for opposition groups, crime syndicates, and guerrillas to coordinate their actions more effectively and to oppose the government in power. The more successful these groups are, the less ability the government has to govern. Eventually, regions of the country fall sway to these opposition groups and the government loses control and sovereignty over them entirely.

Information Technology and Technological Acceleration. The information revolution will continue to change the communication, sharing, storage, retrieval, processing and manipulation of information. Information Age technologies will result in a proliferation of communications and information devices that will lead to increased cultural and political consciousness. The power of shared information and the ability to target information to interested individuals and groups will challenge the authority of businesses, institutions and governments. Rapid technological change is disrupting society in every way. Information technology is allowing business and government to reduce middle management and staffs. It is changing the business model from large integrated

firms which offer long-term employment to its employees to small, specialized firms networked together with other firms in complex business arrangements employing contingent workers. This vast change in the nature of business and institutions is still underway, but has already led to serious economic dislocation and increased job insecurity. As the information revolution disrupts the social, political and economic fabric of society, weaker societies may fall into conflict.

The Future Military Environment

The information revolution is changing the nature of warfare. However this change is in its infancy and its eventual end-state is still hard to discern. Like the industrial revolution that preceded it, the information revolution will cause transformation in some areas of the world while leaving others relatively untouched. Today, the world is divided into three bands of militarily capability.

First are the armed forces of the advanced information based societies. These armies seek to leverage the power of the information revolution to reduce their manpower needs while simultaneously, exponentially increasing their effectiveness and efficiency. They employ Information Age technologies to operate with precision in all aspects of their operations. They apply military force in a manner tailored to the exact situation, much as an Information Age business performs custom manufacturing to the exact needs of a client. The capabilities of these types of armies are still evolving and will for some time as the information revolution matures.

Second are the armed forces of industrial based societies. These armies use the industrial power of their manufacturing base to overwhelm their enemies with mass. They

employ mechanized-armor formations and airpower in a relatively sophisticated manner. However, they must make up for their inability to tailor and deliver force exactly where needed by applying large amounts of force in order to make sure they apply enough where needed.

Third are the armed forces of the non-industrial, underdeveloped states. These armies are based on infantry manpower. They attempt to overwhelm their enemies by sheer human force. In open combat against either of the first two types of armies they will likely fail. However, they are well suited to combat in areas, such as urbanized terrain, mountains, dense forest or jungle, which negate the advantage of the more advanced armies.

The decline of national sovereignty coupled with the rise in influence of supranational organizations means that future war will often be fought by coalitions of nation-states augmented by various supranational and transnational organizations. However, assembling these coalitions, given the disparate national interest, economic competition, regionalism, and second-guessing by media commentators will be more difficult than ever. Holding them together in an era of instantaneous information will be yet more difficult.

The destructiveness of high-intensity information based operations will limit its occurrence in the same way that the destructiveness of nuclear weapons limited their use and usefulness. The military environment of the future will be more complex than in the past. The economic dislocation, decreasing sovereignty, resurgent nationalism, ethnic conflict and increasing dichotomy in wealth will create a milieu of social, economic and political conflict. The types of forces that may oppose each other in conflict will be as

disparate as the range of the economies from which they draw their resources. They will include armed forces that range from the technologically advanced armed forces of advanced information states to the infantry based forces of the underdeveloped third world. Non-state forces such as insurgencies, crime syndicates and terrorist groups will use varying levels of sophisticated Information Age technologies to leverage their limited force capabilities and pursue their goals.

Information Age technologies, especially computers and telecommunications may be fielded to otherwise relatively unsophisticated armies to greatly enhance their capabilities. Smart weapons with Information Age technologies to guide them are increasingly available on the world market for those with the cash to purchase them. Modern telecommunications, computers and smart weapons will be found at many of the flash points around the world that arise due to the impact of social, political and economic trends unleashed by the combination of the information revolution and the end of the cold war. Advanced information-based armies must realize that the capabilities these systems provide to otherwise technologically unsophisticated forces will transform the nature of conflict.

For advanced information based societies, the combination of modern weapon systems and Information Age technologies is leading to what some have called a *Revolution in Military Affairs (RMA)*. One outcome of this RMA is an emerging form of warfare — information warfare. Information warfare represents a rapidly evolving, but imprecisely defined field. Information warfare is an outgrowth of two traditional military mission areas — Command and Control Warfare (C2W) and Electronic Warfare (EW). But its potential focus is much wider. United States DoD Joint Doctrine defines

Information Warfare as "actions taken to achieve information superiority by affecting adversary information, information-based processes, information systems, and computer-based networks while defending one's own information, information-based processes, information systems, and computer-based networks." [46]

Other writers would broaden the term information warfare to include not only the information, information-based processes, information systems, and computer networks discussed in the U.S. DoD definition, but also the leveraging of information technologies to achieve greater effectiveness and efficiencies with traditional weapon systems and forces. This broadened perspective might more properly be called information-based strategy or information-based operations.[47]

From the changes brought about by the information revolution two broad areas of change in the environment of conflict emerge. First, Information Age technologies will provide a series of capabilities, that when combined with traditional forces and weapon systems, will produce a new kind of military force with the potential to be exponentially more effective and efficient. Second, the reliance on information technologies produces both new opportunities in warfare to attack the information systems of enemies and likewise brings threats against United States information infrastructure. The combination of these two broad trends is changing the nature of the battlefield.

Current and future computer and information technology will fundamentally alter the procedures used by military commanders and their staffs to prepare and organize for war and stability operations. This technology has significantly increased the amount of information available, while simultaneously decreasing the time available for making decisions.[48] The technological revolution in information operations will continue into the

twenty-first century forcing commanders to keep pace with an ever-increasing operational tempo.

Acceleration of the operational tempo will require commanders and staffs, at all levels, to manage time and control the tempo of operations more effectively. To keep pace with the increase in operational tempo, information must flow faster than ever before. Military leaders must learn to think differently. Rapid changes on the battlefield will increase the number of new and unexpected problems, increasing the amount of information needed. Military leaders will have more information available to them over increasingly compressed spans of time. They will have to make decisions quicker and execute those decisions over greater distances and in decreasing time. They will orchestrate fire and maneuver under more diverse conditions while maintaining cohesion among units dispersed over a larger battlespace.[49] Information Age technologies will compress the strategic-operational-tactical battlefield paradigm down to two or perhaps even one level. Although the changes in the physical battlefield are significant, the ability to attack a nation's information infrastructure using Information Age weapons is even more significant.

As advanced information societies come to depend in every way on their computer networks and supporting telecommunication systems they become strategic targets of the first order. In a precursor of attacks that may occur in a much more deliberate fashion in the future, hackers attacked AT&T's long distance switching system on January 15, 1990. AT&T lost fifty percent of its long distance switching system for over nine hours. The attack was carried out with just thirteen lines of code. To locate the problem and resurrect the network, AT&T had to examine millions of lines of codes with teams of engineers.[50]

The use of computers, networks and software to attack the enemy's information systems and their data with the goal of deceiving them, compromising them, replacing data, taking control of the resources they control, denying there use to the enemy or even destroying them or the systems they control is possible. This is an entirely new battlefield and one that is in its infancy.

The information revolution has made the world increasingly interdependent. Nation-states cannot act with the same degree of sovereignty and autonomy that was possible only a few decades ago. The boundaries between military and political action are blurring. Likewise, the differences between nation-states and other organizations are less clear. For the advanced information based armies, the difference between the tactical, operational and strategic levels of war are collapsing. Information technologies have increased the number of political actors that have influence in any international crises and consequently are making it more difficult to arrange decisive solutions.

The Elements of National Power in the Information Age

The information revolution is changing the impact and usefulness of the traditional elements of national power. The United States recognizes four broad areas of national power — Diplomatic, Information, Military and Economic power. As the information revolution leads to greater globalization, increased economic interdependence, a rising number of influential supranational, transnational and subnational organizations, and decreasing national sovereignty, it is also having an impact on the elements of national power.

Diplomatic Power. The information revolution has changed the nature of diplomacy. For centuries, diplomacy has been the tool of states by which crises have been averted and conflicts ended. Diplomacy begins with the gathering of information about countries and regions of interests. To develop good policy, a decision-maker's information must be accurate and his understanding of it clear. Traditionally, this information was gathered by embassies located in foreign countries. The ambassador, as the President's personal representative, oversaw a staff charged with representing United States interests. This staff gathered information, prepared periodic reports and forwarded them to Washington.

Today, the ambassador and his staff have many competitors supplying information to the State Department and the President. First and foremost are the news media. Satellite communications enable the media to report on events in many cases as they are happening. Telephones, e-mail and other communication systems bring additional information from many disparate sources. The ambassador can find himself in the situation of knowing less about a given situation occurring in his country than those in Washington know.

In addition to reporting news of foreign events, television has come to play a significant role in diplomacy. It has become a medium for directly sending messages between nations. In times of crises or tension, national leaders often make statements to the press that represents the country's position. During the Persian Gulf War, President Bush and Sadaam Hussein both used this medium to represent their respective country's position to each other and the world. This use of television bypasses one of the traditional roles of the ambassador.

Despite the role that television plays in conducting public diplomacy between nations, diplomacy is often better conducted quietly off the world stage. Often information technologies frustrate this by casting the glare of public disclosure on sensitive negotiations that sometimes would better progress in private. In the Information Age, conducting private discussions and making private agreements has become much more difficult. The multiplicity of special interest groups virtually assures that some group will oppose the initiative being considered. If these groups become aware of the discussions, they can use the considerable power of the media, the Internet and telecommunication systems to bring political power to bear on the participants in the negotiations in an attempt to disrupt or frustrate the talks.

The availability of information to many different people in the executive branch, the legislative branch and various special interests groups can make it difficult to formulate clear policy. The widespread availability of information allows competing interests to advocate their policy positions. This process can sometimes produces a cacophonous noise that confuses the policy and can lead to miscalculations and misperceptions among foreign governments.

Globalism and the rise of supranational and transnational organizations provide other challenges to traditional diplomacy. These organizations can challenge the legitimacy of the ambassador as the sole representative of his country to the nation to which he has been assigned. Transnational corporations that are nominally American may have different policy goals, because of their global orientation, than the ones the ambassador represents on behalf of the United States. Likewise, supranational

organizations, of which the U.S. is a member, may take a position on a policy issue in opposition to the U.S. view.

Diplomacy has been weakened in many ways by the effects of the information revolution. It does not work well in the glare of public disclosure. Paradoxically, a greater amount of information available to greater numbers of people does not lead to better policy. Quite the opposite, it often leads to gridlock. The ability to use diplomacy to mediate crises and avert or end conflict is directly challenged by public disclosure of negotiations, and the involvement of larger numbers of people.

Information Power. Information Age technologies make much more information available to individuals, groups and governments. Worldwide television, radio and other information networks make it possible to distribute information to targeted audiences in ways never before possible. Governments have many channels through which to present information in pursuit of their policy goals. Conversely, those who oppose a government's policy also have many channels through which to present their countervailing arguments. Information technologies make it possible for individuals and special interest groups to challenge the authority and credibility of the government.

Prior to the advent of widely available information, the government instrument of information power was much more potent. The government could decide the message and largely control the distribution medium. Through the use of government sponsored networks such as the Voice of America, the United States government could pursue focused information campaigns directed at specific nations, governments or peoples. Today, the Voice of America is only one voice among many competing for the attention of the targeted audience. In the future, as choices of information media increase, the impact

of a government sponsored information provider like the Voice of America will be even less. As Information Age technologies mature even further, individuals will be able to focus the type of news and sources of news they would like to receive. The world will transition from mass media provided information to personalized information services.

The ability of the government to pursue a particular information policy is challenged by the multiplicity of media sources. The daily news cycle has disappeared to be replaced by the continuous news cycle. The flow of media information challenges governments and sometimes forces them into policy changes. The rapid flows of information compresses reaction times and accelerates required decision making. The ability of many non-state actors to weigh in on issues, offering opinions, alternative policies and criticisms of current government policy undermine the governments use of the information aspect of national power.

Military Power. Knowledge is power. These three simple words sum up one of the key characteristics of the information revolution. In conflict, armies gain competitive advantage by massing combat power at the decisive point on the battlefield. To do this the commander must first identify the decisive point, then identify the decisive time, and finally select and arrange the necessary combat forces on the battlefield to generate combat power. All of these activities require information. Information Age technologies are revolutionizing the battlefield by providing the commander with a level of situational awareness that was not available until recently. Information Age technologies have the potential to make military forces much more effective and efficient and thus increase their utility as an instrument of national power.

However, Information Age technologies also pose many problems to nations facing conflict. Some of these problems may lessen the utility of the military instrument of national power. In the near future, news organizations may deploy satellite reconnaissance platforms with high-resolution cameras. They can already buy imagery from Japanese, Indian, Russian and French satellite platforms.[51] They might use this capability to gather information on troop deployments and activities. Increasingly the media views themselves as impartial third parties to many conflicts. Peter Arnett made this argument in his defense of remaining in Baghdad during the Persian Gulf War. If the media see themselves in the role of a third party and obtain satellite imagery of the theater of operations, the military would be unable to conduct movements that might gain them tactical or strategic advantage. Without the element of tactical or strategic surprise, military operations will be much more difficult to conduct and carry higher risks.

Another conflict arises when a nation decides to pursue a policy of supplying the enemy with false information. In an information society, the government is held to a high standard of truth. If the government pursued a policy of supplying false information in order to deceive the enemy, the truth might well be discovered and published by groups who oppose the government's policies. The wide availability of information and the ability to distribute information widely at little cost gives small organizations and even individuals the ability to oppose the state's policies. They can generate political pressure from within and outside the state that might make it difficult to pursue its policies.

Information Age technologies may enable armed forces from third-world nations and non-state entities to leverage their capabilities so as to become a significant opponent in an asymmetric battlefield of their choosing. The lessons of the Persian Gulf War

indicate the futility of opposing an advanced information state on its own terms. If the United States can be drawn into an asymmetric battle environment where it can not apply its strengths, the political will to pursue the national policy that led to the introduction of armed forces into the situation may wane.

Economic Power. In assessing power in the Information Age, the traditional measures such as land, geography, population, and natural resources have declined. In their place have arisen the importance of technology, education, and institutional flexibility. The nature of conflict between states is changing. In the agricultural and industrial eras, states derived their wealth from the land and natural resources they held. During these eras, states could gain additional wealth by acquiring or seizing additional land and natural resources. These land and resource incentives fueled worldwide imperialism and conflict for nearly four hundred years. Less developed societies which derive their wealth from agriculture or natural resources may still enter into conflict in order to seize new land or resources. In information societies land no longer returns the dividends it once did. Thus, these societies have little incentive to seize land or resources.

Globalization has produced a new dynamic for nations whose economy is based on information and services. In these nations, their economic strategy is at least as important as their military strategy. Ambassadors have become foreign trade and investment representatives. The United States National Security Strategy specifies "promoting prosperity at home" as a specific goal. Intellectual capital is an information state's most important resource. The modern information economies are linked together in a complex web of international relationships. The more connected they become the less likely, individual states will engage in physical conflict with their primary partners.[52]

Economically the world is becoming more intertwined while at the same time the differences in wealth are making it more divided. Economic competition can become a form of Information Age conflict. Objectives of economic conflict could include: (1) to improve one's own economy; (2) to build economic strength of one's allies; (3) to improve one's economic advantage over the enemy; and (4) to maintain the friendship of uncommitted nations. The tools of economic conflict would be employed specifically to penetrate the economy of another nation to exploit or sabotage its economy. The goal of economic penetration would be to gain a position of advantage in a sensitive area of a foreign economy.[53]

Conclusions

The information revolution is changing the world in a number of important ways. The power of nearly instantaneous communication of vast amounts of information — a world with information at your fingertips — is shrinking the globe in time and diffusing power to individuals and groups. This in turn, is eroding the power of hierarchies both within business and government and its institutions. The Information Age has given rise to a society of organizations that have special interests and greater influence than in the Industrial Age past. Activities of business and government occur under the scrutiny of these various organizations. Neither government nor business controls their own destiny. Business and non-governmental organizations are increasingly global in outlook. The interconnectedness of the world in the Information Age gives less meaning to national identity. Collectively, these changes are changing the character of global competition, diplomacy, politics, national power and conflict.

While the information revolution has affected Europe, North America and the high-tech countries of the Pacific Rim most, other less powerful nations have been affected also. The post-cold war world has not seen an end to conflict between smaller nations. However, the most likely form of conflict among the advanced information based states is economic. Economic conflict threatens to become the cold-war of the future. The information revolution has placed the nation-state under extreme stress. As national and international problems rise, the widespread availability of information enables special

interest groups to restrict the freedom of action of the state. Additionally, the pressures of globalization, supranational, transnational and subnational organizations, undermine the state.

The widespread availability of computers, networks, telecommunications and the mass media in cheap, reliable forms is fundamentally changing society. The information revolution is changing the paradigm of economic success. Like the industrial revolution that preceded it, the information revolution is transforming societies, economies and international relations. It is creating change and destroying the accepted notion of the old industrial order. Out of the change, disorder and serious economic dislocation a new type of society is arising — an information society.

The information economy that drives the economic engine of the information society is as different from the industrial economy as the industrial economy was from the agricultural economy. The industrial economy was based on access to natural resources and investment capital. The availability of investment capital, natural resources and labor determined the economic destiny of the industrial state. The information economy is based on the exploitation of information and the development of knowledge. Knowledge industries can be located anywhere in the world that has the necessary human capital — the educated knowledge-worker. Information and intellectual capital are the sources of sustainable, long run economic vitality.

Sovereignty is the fundamental characteristic of the nation-state. The information revolution is directly assaulting the concept of national sovereignty. Individuals and groups with access to abundant information and the ability to communicate rapidly and readily among themselves represent a challenge to government. The rise of special interest

groups, who use the power of the computer, networks, telecommunications and the mass media to pursue their narrow interest influence government policy out of proportion to their actual size. Nation-states have increasingly found their freedom of action curtailed by the availability of information both within and outside of their borders.

The information revolution is rapidly giving power to the individual citizen. The Information Age has overcome the physical isolation of people in much of the world and will overcome the isolation in the rest of the world in the future. As people communicate directly with one another all the important relationships that govern modern life are affected. The interactions between the individual and the corporation, between the individual and the state, between one corporation and another, and between one sovereign government and another are being fundamentally altered. Information Age technologies have compressed space and time. They have eliminated intermediate layers of management that existed to process and filter information. The information revolution fundamentally is a communications revolution of immense scope.

The information revolution is changing the environment of conflict. The revolutionary changes in computers, networking, telecommunications and the mass media are fundamentally changing the world. Distance, geography and national borders mean far less than they did twenty-five years ago. The combination of the mass media and the Internet are spreading cultural changes throughout the world, and in some areas seeding unrest and dissatisfaction. International politics, once the purview of diplomats and heads of state is now often affected by special interest groups, assembled as virtual organizations held together by computer networks, Internet newsgroups and e-mail. Today, diplomacy is often played out on CNN, as nation-states communicate messages to one another. The

widespread availability of nearly instantaneous information and media images is making it more difficult to govern and is eroding national sovereignty. Computer networks are moving information past normal hierarchical channels and weakening organizational hierarchies. Globalization, transnational markets, transnational organizations and the rise of power of small groups and individuals define this new era. The information revolution is shrinking the globe in terms of time and is turning it into a true global village.

The Information Revolution

> We might say that in the nineteenth century the wealth in California came from the gold in our mountains; today it comes from the silicon in our valleys.
>
> William J. Perry[54]

The Power of Computers

The computer is the symbol of the information revolution. The world's first general purpose, digital, electronic computer, the ENIAC (Electronic Numerical Integrator and Computer), was completed in 1946 by John Mauchley and J. Presper Eckert at the University of Pennsylvania.[55] The ENIAC marks the beginning of the computer age. This machine filled a 30 by 50-foot room, weighed 30 tons, contained 18,000 vacuum tubes and consumed 150 kilowatts of power.[56] The ENIAC was an impressive machine, but it and its successors did not immediately take the world by storm. These machines were large, complex, and unreliable. They seemed to be useful only for very specialized tasks. In 1948, IBM thought the entire computer market might be satisfied by four or five machines and declined to enter the computer market. IBM changed its mind in the mid-50's and by the mid-60's there were over 15,000 mainframe computers worldwide.[57]

Though the power of the mainframe computer increased rapidly in the decades following the completion of the ENIAC, their complexity and cost of operation restricted their widespread use. Mainframe computers were installed in environmentally controlled rooms with special power arrangements and tended by specialized technicians and

computer programmers. Early mainframes found homes in the corporate world, processing payroll, maintaining inventory and performing other well-structured but tedious, error-prone actions. The scientific community also found immediate uses for computers to perform calculations that could never be attempted without the power of high-speed, digital computation.

By the 1970's, the development and maturation of general-purpose computer programming languages such as FORTRAN and COBOL put the power of the computer within the reach of more people. Computer programming began to be taught widely in universities and even some high schools. Access to computer terminals was becoming more common in universities, businesses and scientific research labs. However, the average person had never seen a computer terminal, much less had access to one.

The invention that would make it possible to develop a personal computer was the development of the microprocessor by Intel in 1971 — the computer on a chip. The microprocessor was the end result of several key developments in electronics that have fundamentally altered the world. The first development occurred at Bell Labs in 1955 when three investigators, William Shockley, John Bardeen and Walter Brattain invented the transistor.[58] The transistor replaced vacuum tubes that tended to fail often in electronic equipment. The transistor was not only more reliable, but also smaller and generated less heat. The invention of the transistor launched the incredible miniaturization of electronics that continues today. The second invention was an outgrowth of the first — the integrated circuit.

As designers sought to build ever more complex devices they were confronted with the "tyranny of numbers." Each transistor had three wires; each diode, resistor and

capacitor had two wires. As designs grew more complex, electronic devices had hundreds of thousands of soldered connections to assemble. Manufacturing was becoming impossible. Robert Noyce and Jack Kilby working independently produced the first integrated circuits in 1958.[59] The integrated circuit allowed an entire assemblage of transistors, capacitors, resistors, diodes, and their interconnections to be fabricated out of a single silicon wafer. This development allowed further miniaturization and the integration of circuits together on the silicon chip. The number of circuits that could be integrated on a chip increased rapidly from tens in the late 50's to thousands by the mid-60's. It was while observing this rapid development that Gordon Moore predicted in 1964 that the number of circuits on a chip would double roughly every 18 months. This observation has become known as Moore's law and still holds today.

The microprocessor is a sophisticated integrated circuit designed to support a particular function. The microprocessor is the engine that powers the information revolution. From its humble beginnings in 1971, designed to be the heart of a Japanese calculator that was never manufactured, the microprocessor has, by today, found its way into everything from computers to refrigerators. It has created an era of intelligent machines. These machines serve us in every facet of life and are increasingly interconnected.

The miniaturization of integrated circuits continues today. The number of transistors in a microprocessor has increased 20 times in the last ten years. The Intel 80386 (3rd generation) microprocessor introduced in 1985 had 275,000 transistors while the Pentium Pro (6th generation) introduced in 1995 has 5.5 million transistors. By the end of the decade, microprocessors with over 50 million transistors should be available.[60] The

incredible miniaturization of electronic devices has allowed engineers to design powerful personal desktop and portable computers. The power of these computers is increasing so fast, that the average product cycle for personal computers and related products is less than six months.

Computers are merely electronic devices that execute a set of instructions known as a computer program. One measure of a computer's power is the number of instructions per second that it can execute. Intel's first microprocessor, the Intel 4004, could execute 60,000 instructions per second. Intel's latest processor, the sixth generation Pentium Pro, executes 440 million instructions per second (MIPS).[61] This rapid increase in power will continue for the foreseeable future. Today, this computing power enables computer programmers to design sophisticated computer interfaces which are extending the power of the computer from the technical specialist to the average citizen.

The increasing power of computers enables the use of computer software that provides natural interfaces and intelligent assistance to users. Today, voice dictation programs work well enough to control all aspects of interfacing with a computer. They also allow a user to dictate discrete text to the computer at a rate that exceeds the rate a trained typist can type. Computer vocalization has improved to the point that it is used routinely by businesses in telephony applications such as voicemail. In a short few years, the average user will communicate with his computer in natural language the same way he might talk with another person.

Today's software monitors a user's actions and can make recommendations to him on the best way to accomplish a task or correct an error. Other software can act as an assistant for a user and carry out tasks for him. These intelligent agents are already being

used to gather information from diverse sources according to a specified profile and then deliver it to the user's personal computer. In the future, intelligent agents will become sophisticated enough to fulfill the role of a personal assistant that can carry out tasks from making travel arrangements to monitoring information and notifying the user when certain events have occurred.

Computers come in all shapes, sizes and capabilities. Today's computers routinely have the capability to display text, graphics, video images and reproduce sound. Common desktop personal computers now are capable of sophisticated three-dimensional graphics previously found only on engineering workstations. This technology allows users to produce multimedia documents that make use of a range of human senses to convey information. Today's documents may contain text, sound and video. They may contain animated elements. Documents may have hyperlinks that tie them to other documents on the same computer or a different computer on a network. In the future, computer users will be able to don special bodysuits, gloves and eyeglasses or visors and enter a virtual world where they can not only see and hear but feel as well.[62]

Today powerful computers may be as small as an inch thick notebook of paper and weigh only 4 or 5 pounds. Once natural language processing becomes the predominate method of inputting information, the computer will no longer be restricted by the need to have an adequately sized keyboard as an input device. This means that further miniaturization will allow very powerful computers to be scaled down even further. The future personal computer may be as small as your wallet today and may serve that function as well as many others.[63] The computer is the workhorse of the information revolution

and the window into a vast store of information stored on networked computers around the world.

The Power of Networking

In the early days of the computer age, each computer was a separate entity. If a user wanted to share data with another user on a different computer, then the data had to be physically transferred on punched cards, magnetic tape or other information storage media. The computer network changed all of that. With a network, a user could directly transfer data over the network to any other computer on the network. This powerful technology has become a catalyst accelerating the information revolution.

In 1968, the Defense Advanced Research Projects Agency (DARPA) proposed the development of a network that would allow computers in separate locations to communicate with one another. By 1969, four computers were operating on ARPANET. Over the next six years, the ARPANET increased to 100 nodes located primarily at universities and defense contractor research sites. The network transitioned from DARPA sponsorship to other government sponsors and finally to commercial sponsorship. It slowly gained sophistication and by 1983 had grown to 200 nodes. Throughout the 1980's, it continued to grow and spread throughout the academic community both within the United States and overseas.

In the early 1990's, a group of theoretical physicists at the European Center for Particle Research (CERN) developed the set of protocols that became the World Wide Web.[64] Prior to 1992, the Internet, as DARPA's creation had become known, was the domain of university researchers and graduate students. Its interface was arcane and its

users took a certain delight in the technical knowledge required to use the information resources present on the net. The World Wide Web changed everything. The Web had a user-friendly graphical interface and was based on the principle of hypertext links. The hypertext links allowed users to click on a highlighted link and be instantly transferred to a related piece of information located somewhere else on the Internet. The easy to use interface and the access to immense amounts of information caused an explosion in popularity of the Internet. In a little less than three years, the Internet went from an obscure academic research support environment to a multi-billion dollar industry growing at phenomenal rates.

Networks are fundamentally communications systems. They allow computers to communicate with one another. A direct byproduct of DARPA's sponsored network research was the development of the Ethernet protocol by Xerox's Palo Alto Research Center in 1976. The Ethernet protocol became the basis for the development of the corporate Local Area Networks (LAN). These networks tie computers together at a single work-site. Organizations connect their LAN's together to form Wide Area Networks (WAN). These private networks, now often called Intranets, are the heart of corporate, governmental and private networking. In the 90's, many of these LAN's and WAN's were connected to the Internet providing worldwide connectivity between computers and contributing to the explosive growth of the Internet.

With a network, data may be stored in one location and the user may work at another, accessing the data over the network, as he needs it. Networks allow organizations to form distributed workgroups. Members of the organization may work together on the same project, yet not be located at the same work site. They might

communicate by electronic mail (e-mail), conduct shared whiteboard conferences where all can see the same virtual whiteboard on their computer screen, conduct a multi-point videoconference over the network or just post shared documents on a network server.

The Internet has become a massive public network that stretches into virtually every country in the world. In early 1996, the Internet interconnected more than 25 million computers in over 180 countries and continues to grow at a dramatic rate. Users can use the Internet to operate a distant computer from a remote location (telnet), to transfer files between a distant computer and a local one (ftp or file transfer protocol), or for reading files on a remote computer. This last capability has become embodied in the World Wide Web. The hypertext transfer protocol that forms the basis of the World Wide Web allows the user to access a computer anywhere on the Internet that functions as a Web server and has documents available to be read. These documents may contain textual information, as well as, pictures, sounds, and video information. [65]

The power of the World Wide Web lies in several areas. First it is graphical and easy to use. Second, it allows the user to view and *interact* with a wide variety of information including magazine archives, current world and business news, virtual libraries, financial information, commercial product information, political information, religious information and discussion or news groups on virtually any technical, social or recreational subject imaginable. The third feature of the Web that is particularly significant is its hyperlinks. Any Web page can have links to another web page, a picture, a sound file or a video file on any other computer connected to the Web. The user clicks on the hyperlink and he is transferred to new information. These links exists across the global Internet to form a large-scale distributed, multimedia knowledge base that relates

words, phrases, images or other information. Finally, the World Wide Web is a low cost publishing medium that enables individuals and groups to reach large audiences.

The concept of the network arguably ranks just after the microprocessor as the most significant development of the information revolution. The computer network ties computers together and transforms them from unitary machines that execute programmed instructions into sophisticated communication systems. The network has become the computer. Computer networks bridge the barriers of time and distance allowing people to share information and work together.

The Power of Telecommunications

In 1844, Samuel Morse transmitted the immortal words, "What hath God wrought!" from his telegraph key located in the chamber of the Supreme Court in Washington, DC forty miles to his assistant Alfred Vail at the Baltimore train depot.[66] With this simple transmission the telecommunications industry was born. Alexander Graham Bell's telephone arrived in 1876 and over time it replaced the telegraph. The telephone had an effect on society similar to that of the telegraph. It compressed time and space. However, the telephone had an even greater impact in this regard, as it eventually became a nearly universal service and was located in homes and businesses.

For over one hundred years the telephone system evolved, but most of its fundamental components would still have been recognizable to Alexander Bell. Today, the revolution begun by the microprocessor is changing the telecommunications industry drastically. Optical fibers thinner than human hair carrying digital signals transmitted by lasers are replacing copper wires carrying analog signals. Each optical fiber has a capacity

a thousand times greater than the copper wire they replace. These optical cables form the backbone of the high-speed data networks used by both private Intranets and the commercial Internet.

The past decade has also seen the introduction and widespread usage of the cellular phone — a portable phone without wires. Cellular phones weighing as little as three ounces can connect a user to the telephone network within any area that is covered by cell transceivers. Cellular modems enable portable computer users to access their network connections from anywhere a cell-phone call can be established. Cellular systems are more economical to install than traditional wired systems and have become the system of choice in many developing countries.

In the near future, it may be possible to make a cellular phone call from anywhere on the planet to anywhere else regardless of whether the caller is near a cell transceiver or not. Motorola is leading a consortium which has launched an ambitious $5 billion project called Iridium, which will place 66 cellular communications satellites in low-earth orbit. Once the network is established Motorola projects initial user cost to be $3.00 per minute. The cell phone used in the Iridium system is very similar to the types used with current cellular systems.[67] Significantly, these systems will not require the special antennas used on current satellite phones that use geo-stationary satellites.

Motorola is not the only company attempting to establish planet-wide communications services. At least six other projects, led by a number of companies, employing various arrays of satellites and orbits, will offer a variety of communications services. One project, Teledesic, led by a partnership between Microsoft and McCaw Communications, plans to build a broadband data network comprised of 840 satellites in

low earth orbit. Teledesic will provide Internet connectivity with a data rate of up to 28 megabits per second without wires from anywhere on the planet. At these speeds the proposed $9 billion network will support high-speed multimedia networks for corporate Intranets, Internet videoconferencing and data transfer.[68]

The telecommunications industry provides the infrastructure that supports the information revolution. Its systems provide the arteries through which information flows. Current telecommunications infrastructure is one of the primary restrictions on widespread high-speed data access, especially for home-users. The system was designed to support voice communications. The needs of data communications are different. The technology to support high-speed data communications exists, but it takes time to replace infrastructure. The solution may well lie in the proposed satellite systems rather than rewiring every household.

The Power of Mass Media

Traditionally the mass media meant the three large television networks and perhaps the Hollywood movie studios. Today the consumer has many more choices. The advent of cable television provided the average cable television subscriber with between 30 and 50 channels of video information and entertainment. Cable television spawned the creation of specialized channels dedicated to one type of programming. Today in the United States, dedicated information channels such as the Weather Channel and the Cable News Network (CNN) provide information on a repetitive regular schedule that allows the viewer to watch at any point in the day or night. Other dedicated subject channels, such

as the History Channel or the Discovery Channel provide documentaries and educational programming.

Television networks have used satellites to broadcast their signals to network affiliates for many years. Many people who did not live in an area where they could get cable or receive the transmitted signal of a local television station installed their own satellite dish antennas and receivers at considerable cost. Today, these systems are being supplanted by Direct Broadcast Satellite (DBS) television. DBS satellites can offer as many as 200 channels of video and stereo audio to subscribers. Subscribers need only a small 18" satellite dish and a low cost receiver. The digital satellite signal is far sharper than any other television signal available.

DBS has also been used to provide high-speed World Wide Web connections for Internet users. In this application, the user transmits his Web page request via modem over his phone line to the DBS facility. At the DBS facility, computers connect to the appropriate Web page via a high-speed data link. The retrieved Web pages are then uplinked to the DBS satellite where it is broadcast to the user and displayed on his computer. The speed of this system is comparable to a high-speed, leased line connected directly to the Internet.

Cable television systems are beginning to offer video-on-demand services. To use this service, the user selects a video which he would like to watch from a menu of alternatives, then transmits an order to the Cable Company, who then transmits the selected video to the customer's television. Currently, video-on-demand has offered mainly movies. But as the system matures, there is no reason why videos on virtually any subject could not be made available.

The Power of Convergence

Computers, networks, telecommunications and the mass media are converging into one powerful information system. Everything from text documents to full-length feature films can be stored in digital form and can be transmitted over computer networks. An individual will decide what information he wants, when he wants and how he wants it. An intelligent agent will retrieve it, package it and deliver it to the users display and sound system at the appropriate time.

When computers, networks, telecommunications and the mass-media systems are combined, it means you will be able to pause your favorite TV show when someone knocks on your door and then resume it exactly where you left off later. It means that you can arrange your television entertainment according to any schedule you wish as all video will be available from computer servers at any time. It means that after you watch a news story on CNN, you can request more information and be transferred to back up video files that support the story. After watching those you might be offered newspaper articles in the Washington Post or the New York Times on the same subject. From there you might link to detailed analyses or studies produced by research organizations. It means you will have access to virtually unlimited information. The possibilities are limitless!

Notes

[1] Carver Mead quoted in Walter B. Wriston, *The Twilight of Sovereignty* (New York: Charles Scribner's Sons, 1992), 110.

[2] *Webster's New Collegiate Dictionary* (Springfield, MA: G&C Merriam Company, 1977), 592.

[3] Ibid., 992.

[4] Linley Gwennap, "Birth of a Chip," *Byte* 21:12 (December 1996): 77.

[5] Ibid., 77-78.

[6] The first Intel Microprocessor, the Intel 4004, was compared by Bob Noyce, founder of Intel with the ENIAC, the world's first general purpose, digital computer in a 1977 *Scientific American* article. The Intel 4004 sold for $300 and this processor was not only more powerful than the ENIAC, but as Noyce noted: "It is twenty times faster, has a larger memory, is thousands of time more reliable, consumes the power of a lightbulb rather than that of a locamotive, occupies 1/30,000 the volume and costs 1/10,000 as much." This trend in microprocessor power and dropping costs continues. Intel's mainstream Pentium CPU's range between $100 and $500 and are thousands of times more powerful than its first CPU which it sold in the same price range. The same economics apply to other aspects of the computer as well. For instance the first hard drive produced by IBM for personal computers held 10 megabytes and sold for $3,000 or $300 per megabyte. Today, 1.6 gigabyte hard drives commonly used in personal computers are sold for $200 or $0.125 per megabyte. Gates, Bill, *The Road Ahead* (New York: Penguin Books, 1996), 30, 36.

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[8] Steve Banks and Carl Builder, "Seizing the Moment: Harnessing the Information Technologies" (monograph, RAND, 1992), 12.

[9] Alvin Toffler quoted from. *Powershift: Knowledge, Wealth, and Violence at the Edge of the 21st Century*, pt. 1, ch. 2, "The Democratic Difference" (1990). Quote contained in *The Columbia Dictionary of Quotations*, electronic edition contained in Office 97 Microsoft Bookshelf (New York: Columbia University Press, 1993, 1995).

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[11] Ibid., 3.

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[15] Ibid., xiii, xvi.

[16] Lester C. Thurow, *The Future of Capitalism, How Today's Economic Forces Shape Tommorow's World* (New York: William Morrow and Company, Inc., 1996) 7.

[17] Ibid., 8-10.

[18] Marshall McLuhan and Quentin Fiore, *War and Peace in the Global Village*, (New York: McGraw-Hill, 1968) cited in Steve Bankes and Carl Builder *Seizing the Moment: Harnessing the Information Technologies*, (Santa Monica: RAND, 1992), 4.

[19] "In a Frenzy, Math Enters Age of Electronic Mail," *New York Times*, June 26, 1990, cited in Bankes and Builder, 11-12.

[20] Don Tapscott, *The Digital Economy, Promise and Peril in the Age of Networked Intelligence*, (New York: McGraw Hill, 1996),303-305.

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[22] Micheal Hammer and James Champy, *Reengineering the Corporation, A Manifesto for Business Revolution*, (New York: HarperBusiness, 1993), 90.

[23] Tapscott, 92.

[24] Bankes and Builder, 15.

[25] Thurow, 65-66.

[26] Ibid., 67.

[27] Ibid., 68.

[28] Ibid., 69.

[29] James D. Davidson and William Rees-Mogg, *The Sovereign Individual, to Survive and Thrive During the Collapse of the Welfare State*, (New York: Simon and Schuster, 1997), 179.

[30] Walter B. Wriston, *The Twilight of Sovereignty,* (New York: Charles Scribner's Sons, 1992), 40-41.

[31] Ibid., 85-86.

[32] Richard Rosecrance, "The Rise of the Virtual State," *Foreign Affairs* 75:4 (July/August 1996), 50-52.

[33] Beniger, 226-230.

[34] Brian Nichiporuk and Carl H. Builder, *Information Technologies and the Future of Land Warfare*, (Santa Monica: RAND, 1995), 27-32.

[35] Wriston, 130.

[36] Ibid.. 130-131.

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[39] Walter B. Wriston, "Technology and Sovereignty," *Foreign Affairs* 67:2 (Winter 1988/89), 70.

[40] Wriston, *The Twilight of Sovereingty*, 61.

[41] Jean François Lyotard, *The Postmodern Condition: A Report on Knowledge,* Introduction (1979). Quoted by *The Columbia Dictionary of Quotations,* electronic edition contained in Office 97 Microsoft Bookshelf (New York: Columbia University Press, 1993, 1995).

[42] Henry Kissenger, *Diplomacy*, (New York: Touchstone, A Division of Simon and Schuster, 1994), 17, 58-63.

[43] Ibid., 21-23.

[44] Kissenger defines the major states as the United States, Europe, China, Japan, Russia, and India. Kissenger, 22.

[45] The basic idea for these categories is taken from TRADOC PAM 525-5, Chapter 2, "The Strategic Environment." I have enhanced the concepts presented in the discussion in the TRADOC PAM amplifying and extending some of the ideas presented there. TRADOC PAM 525-5, *FORCE XXI Operations, A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-First Century*, (Washington, DC: US Army, 1994), 2-1 – 2-3.

[46] Joint Pub 3-13.1, *Joint Doctrine for Command and Control Warfare*, (Washington, DC: GPO, Feb 96), GL-8 – GL-9. Note: This definition will be included in Joint Pub 1-02, Department of Defense Dictionary of Military and Associated Terms, upon approval of its revision. Information Warfare and its definition will be included in Joint Pub 1-02.

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